Improvement of Tear Trough by Monophasic Hyaluronic Acid and Calcium Hydroxylapatite

UWE WOLLINA, MD
Department of Dermatology and Allergology, Academic Teaching Hospital Dresden-Friedrichstadt, Dresden, Germany

ABSTRACT

Tear trough deformities are a sign of facial aging. The anatomical base is well understood. In many patients, minimal invasive surgical procedures are useful to improve appearance. Here, the authors describe the use of monophasic hyaluronic acid dermal filler and calcium hydroxylapatite injection for correction. Forty female patients with a mean age of 50 years have been treated. On average, an improvement of one class of Hidman's severity score could be achieved by single treatment. Mean duration of the effect was 10.1 months for hyaluronic acid and 12.8 months for calcium hydroxylapatite. Adverse effects were mild and temporary. Patients satisfaction was high (95%).
(*J Clin Aesthet Dermatol.* 2014;7(10):38–43.)

Considering facial aesthetics, the periorbital region is one of the most important regions. Facial aging and loss of volume can be recognized easily due to the delicate structure of periorbital skin and subcutaneous tissue. Tear trough or nasojugal groove describes the concavity at the border of the lower eyelid and medial cheek. This hollow area elicits a tired or wearied appearance. The shadow created by this groove is commonly perceived as dark circles.[1]

The tear trough represents also a border between loose tissue of the lower lid and more compact structures of the cheek. This line or border is defined by an anchoring fascia (septum orbitale) to the periosteum of the inferomedial arcus marginalis. This leads to a separation of adjacent fat compartments of the face—inferior orbital from medial cheek and nasolabial fat pads. In contrast to other prominent facial folds, there is an additional structure separating superficial and deep fat pads—the orbicularis retaining ligament.[1] This ligament is stronger in the medial portion, but weaker in the central part. With age, a further weakening can lead to herniation of orbital fat.

Recently, Wong et al[2] succeeded in isolation and characterization of the tear trough ligament. This is an osteocutaneous ligament found on the maxilla between the palpebral and the orbital parts of the musculus orbicularis. It commences medially just inferior to the anterior lacrimal crest and continues laterally as orbicularis retaining ligament.[2]

In the infraorbital region, the superficial musculo-aponeurotic system (SMAS) consists of a network of small fibrous septae, which traverse perpendicularly between fat lobules to the dermis and deeply into facial muscles or periosteum. Loss of maxillary bone projection negatively affects appearance with increasing age. Severity of tear trough deformity correlates with the anterior angle of the anterior face of maxillary sinus.[3,4] Other factors contributing to an aged appearance are loss of skin elasticity, festoons, and musculus orbicularis prominence. The loss of volume indirectly contributes to the tear trough deformity,[5,6] which can be associated with lower lid eye bags. The major factors contributing to tear trough deformity can be described by the trinity of relaxation, atrophy, and ptosis. This makes the correction of tear trough deformities one of the most challenging topics for minimal invasive facial aesthetic procedures.[7,8]

Although various surgical techniques have been developed to correct tear trough deformity, non-surgical techniques have gained a wider acceptance by both patients and medical doctors.[9,10]

PATIENTS AND METHODS

This is a retrospective uncontrolled trial in patients treated with dermal fillers for tear trough deformity. Patients with contraindications to filler injection were excluded.[11] To classify the severity of tear trough deformity, the author used the Hirmand scale.[8] The scale

DISCLOSURE: Dr. Wollina has provided lectures and courses for Pharm-Allergan and Merz Pharma.
ADDRESS CORRESPONDENCE TO: Uwe Wollina, MD; E-mail: wollina-uw@khdf.de

Figure 1A. A 49-year-old woman with Class II tear trough deformity before treatment

Figure 1B. After injection of 0.3mL monophasic hyaluronic acid filler (Belotero Basic)

Figure 2A. A 44-year-old woman with Class II tear trough deformity before treatment

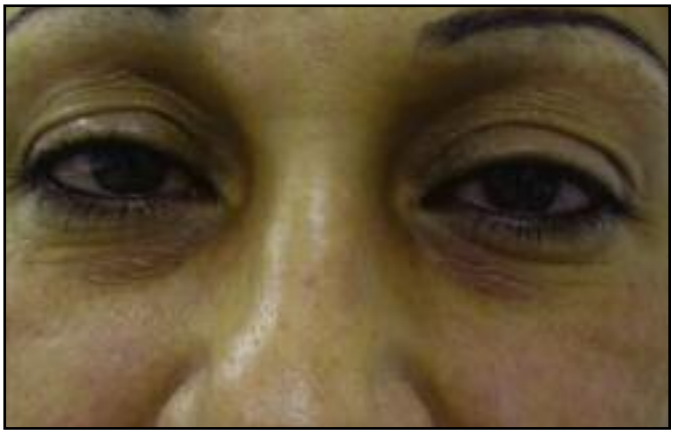

Figure 2B. Marked improvement after injection of 0.3mL monophasic hyaluronic acid filler (Glytone 3).

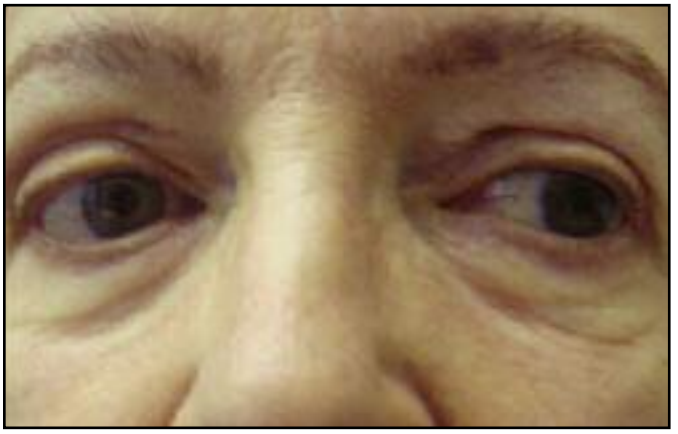

Figure 3A. A 65-year-old woman with Class III tear trough deformity before treatment

Figure 3B. After treatment with 0.4mL monophasic hyaluronic acid filler (Glytone 3). The next step in treatment would be a cheek volume restoration

Figure 4A. A 62-year-old woman with Class III tear trough deformity and pronounced dark circles. There is a significant fine wrinkling of the lower eyelid. Pinch test was positive.

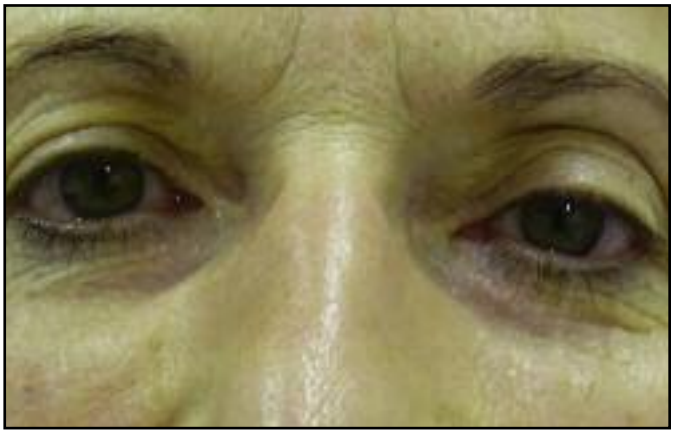

Figure 4B. After correction with 0.5mL monophasic hyaluronic acid filler (Belotero Basic). There is a smoothened transition of the lower lid to the convexity of the cheek. Fine wrinkling of the eyelid cannot be improved by fillers in this case, but radiofrequency would be a noninvasive option.

Figure 5A. A 50-year-old woman with Class II tear trough deformity before treatment

Figure 5B. After microdroplet serial injection with 0.4mL calcium hydroxylapatite (Radiesse)

Figure 6A. A 46-year-old woman with Class III tear trough deformity before treatment

Figure 6B. After linear threading with 0.3mL calcium hydroxylapatite (Radiesse). In the next touch-up, a hyaluronic acid filler can be used to further improve the transition zone to the cheeks.

differentiated between three classes with I as the less pronounced and III as the most pronounced.

Class I is defined as patients with loss of volume limited medially. Class II is defined as patients with loss of volume also in the lateral orbital area and moderate volume deficiency of medial and upper central cheek. Class III is characterized by a full depression circumferentially to the orbital rim.[8]

All procedures were performed with protective gloves. Patients were treated in a sitting position. Make-up was removed and ice packs were placed on the face for several minutes. The area was carefully disinfected by chlorhexidine solution. The clinicians used hyaluronic acid (HA) fillers (Belotero Basic® and Glytone 3®, Merz Pharma, Frankfurt/Main, Germany) with a 30-gauge needle. The orbital rim was palpated. The infraorbital foramen was identified prior to injection since this is a no-go area. Filler injection into the foramen would cause severe nerve and artery compression. Intra-arterial injection can cause embolism with disastrous damage.

The clinicians started in the medial part below the orbital rim with deep periosteal injection and positioning the filler while moving the needle backwards. Care must be taken to avoid HA filler placement while moving the needle out of skin. Otherwise, pigmentation due to the Tyndall effect would be possible. In accordance with the Hirmand scale, further injections are placed centrally and laterally. The amount of filler was dependent on the tear trough class and individual anatomical situation. Usually, the clinicians applied 0.2 to 0.6mL. Thereafter, the area was gently massaged to smoothen appearance. Ice packs were placed onto the skin for a couple of minutes to reduce bruising.

The technique was different when using hydroxylapatite (Radiesse®, Merz Pharma, Frankfurt/ Main, Germany). The filler was diluted by 0.8mL prilocaine 1% (Xylocaine 1%®, AstraZeneca, Wedel, Germany). Serial injections can be performed with microdroplets of 0.1mL. Using a 27-gauge needle, deep vertical injections were placed every centimeter in a line about 1cm beneath the lower orbital rim. This was followed by one to two additional lines beneath with 0.5cm distance in cases of flat medial cheeks. Alternatively, this filler can also be injected during slow withdrawal of the needle (linear threading). The product needs to be placed deep to avoid nodule formation. The author prefered the microdroplets when patients had thin skin. After injection, the area was gently massaged. Overcorrection needs to be avoided. To avoid bumps and nodules, calcium hydroxylapatite should never be placed above the orbital rim. Photographs were taken before and after the procedure. A work-up was done within two to three weeks after first treatment, when necessary. Postprocedural recommendations included avoidance of unnecessary touching of the area, intense sunlight or tanning beds, and saunas for at least two weeks.

RESULTS

Forty Caucasian women between the ages of 32 and 90 years (median ± standard deviation: 50±11.1 years) were treated—31 with HA filler and nine with calcium hydroxylapatite. The mean age was 51±11.8 years in the HA group and 50±7.7 years for calcium hydroxylapatite patients.

TABLE 1. Correction of tear trough deformity by hyaluronic acid fillers

STUDY	n	OUTCOME
De Pasquale et al (2013)	22	Three depots; 90% needed a second injection
Hamman et al (2012)	81	Similar satisfaction with single depot or multiple small aliquots
Kane (2005)	24	91.7% were satisfied
Morley and Malhotra (2011)	100	85% were satisfied
Tung et al (2012)	21	92.6% experienced overall improvement
Viana et al (2011)	25	88% experienced overall improvement

The author utilized Glytone 3 in 10 patients, Belotero Basic in 21 patients, and Radiesse in nine patients. Linear threading was used in all patients with HA filler and three patients with calcium hydroxylapatite. The others were treated by serial punctures and microdroplets. According to Hirmand's classification, six women had Class I, 20 had Class II, and 13 had Class III tear troughs.[8]

All patients improved after one procedure; two obtained a touch-up two to three weeks later (all in the HA group). The average improvement among study patients was one Hirmand class (Figures 1–6). Twelve patients who were classified as having Class II tear troughs before treatment obtained an improvement of two classes. Patient satisfaction was high. Of the 40 patients treated, 38 were very satisfied (95%).

Skin laxity and pronounced fine wrinkling had a negative effect on overall outcome. Adverse effects were seen in 25 of 31 patients treated with HA filler. The adverse effects included minor bruising (13), edema (6), and redness (6). A single patients could show several adverse effects.

All adverse effects were mild and temporary and were gone within two to three weeks after treatment without any medical intervention needed. No Tyndall effects, bumps, or nodules were seen. No hyaluronidase therapy was necessary.

In the calcium hydroxylapatite group, bruising was seen in four patients and redness and edema were seen in two patients. Adverse effects were noted in four of nine patients, but all were mild and temporary.

Duration of effect was between nine and 12 months with

HA filler (10.1±2.4 months). The calcium hydroxylapatite patients achieved a volumizing effect between 11 to 15 months after treatment (12.8±3.9 months).

DISCUSSION

HA fillers have been used to correct tear trough deformity in several studies (Table 1). Vertical supraperiosteal injection of small deposits or linear threading are both recommended, although some authors found no difference between single bolus and multiple injection techniques.[12] The mean volumes necessary for corrections are low (0.2–0.6mL).[12–14] Overcorrection should be avoided.

Although the technique is safe in the hands of experienced users, adverse effects are quite common. Typical adverse effects of dermal filler injection in the tear trough include some degree of bruising, erythema, and local swelling/edema. The Tyndall effect can be avoided by placing the filler deeply periosteally.[15] A very rare complication is diplopia, which can be corrected by the use of hyaluronidase.[16] The author has seen mild and temporary adverse effects in 72.5 percent of patients. All adverse effects disappeared without any medical intervention.

Usually, the filler augmentation will last for about 10 to 12 months.[13] Using 3D photography, mean duration of volume augmentation lasted as long as 14.4 months in an uncontrolled trial (n=20) with non-animal stabilized HA.[17]

Both Glytone and Belotero are brands made of monophasic fillers, but with different cross-linking technologies. Glytone contains mannitol—an antioxidant. Belotero Basic is a monophasic HA filler with a cohesive polydensified matrix.[18] Histological studies suggest a more even tissue distribution compared to biphasic HA-fillers.[19] The mean duration of effect was 10.1 months in this study.

Calcium hydroxylapatite is a relatively new filler working not only as a volume replacement but biostimulant. It consists of calcium hydroxylapatite microspheres of a diameter between 25 to 45µm in a 70% methylcellulose carrier. The volumizing effects last between 12 to 18 months. Loss of augmentation is gradual.[20] This filler type has been used for rejuvenation of the periocular region including tear trough, but it is most important to use safe injection techniques.[21–23] For safety reasons, this filler needs a deep periosteal placement. It is unsuitable for corrections of the lips and for injections above the lower orbital rim.[24]

Dermal filler changes mechanical stress to fibroblasts and extracellular matrix. This results in upregulation of type II tumor growth factor beta-receptor, increased production of procollagen, collagen type I, and tissue inhibitor I of matrix metalloproteinase, and fibroblast proliferation, even in patients of advanced age.[25,26]

In cases of overcorrection or nodule formation, injection with hyaluronidase can rapidly resolve these problems.[27] For touch-up, the author uses an overlay of calcium hydroxylapatite by HA filler. Correction of fine wrinkles of the lower eyelid is more sophisticated. Low viscosity HA fillers with lidocaine, such as Juvederm Ultrasmile® (Pharm-Allergan; Ettlingen, Germany), are suitable, as long as the pinch test is negative. Monopolar radiofrequency technique is another option. The author prefers a series of six treatments before injection of fillers.[28]

Nonsurgical correction of tear trough deformity is a safe and effective, minimally invasive method for middle-aged and elderly women. Selection of patients is important to obtain best results. Ideal candidates are those with thick skin, those with no pseudoherniation of the lower fat pads, and those who avoid tanning beds.[29]

REFERENCES

1. Gierloff M, Stöhring C, Buder T, Wiltfang J. The subcutaneous fat compartments in relation to aesthetically important facial folds and rhytides. *J Plast Reconstr Aesthet Surg.* 2012;65:1292–1297.
2. Wong CH, Hsieh MK, Mendelson B. The tear trough ligament: anatomical basis for the tear trough deformity. *Plast Reconstr Surg.* 2012;129:1392–3402.
3. Levine RA, Garza JR, Wang PT, et al. Adult facial growth: applications to aesthetic surgery. *Aesthetic Plast Surg.* 2003;27: 265–268.
4. Goldberg RA, Relan A, Hoenig J. Relationship of the eye to the bony orbit, with clinical correlations. *Aust N Z J Ophthalmol.* 1999;27:398–403.
5. Muzaffar A R, Mendelson B C, Adams W P. Surgical anatomy of the ligamentous attachments of the lower lid and lateral canthus. *Plast Reconstr Surg.* 2002;101:873–884.
6. Goldberg R A, McCann J D, Fiaschetti D, et al. What causes eyelid bags? Analysis of 114 consecutive patients. *Plast Reconstr Surg.* 2005;115:1395–1402.
7. Sadick NS, Bosniak SL, Cantisano-Zilkha M, et al. Definition of the tear trough and the tear trough rating scale. *J Cosmet Dermatol.* 2007;6:218–222.
8. Hirmand H. Anatomy and nonsurgical correction of the tear trough deformity. *Plast Reconstr Surg.* 2010;125:699–708.
9. Espinoza GM, Holds JB. Evaluation and treatment of the tear trough deformity in lower blepharoplasty. *Semin Plast Surg.* 2007;21:57–64.
10. Massry GG. Comprehensive lower eyelid rejuvenation. *Facial Plast Surg.* 2010;26:209–221.
11. Wollina U, Goldman A, Nauom C. Side effects in aesthetic medicine. Spectrum, management and avoidance. *J Asthet Chir.* 2013;6:103–110.
12. Sattler G. The tower technique and vertical supraperiosteal depot technique: Novel vertical injection techniques for volume-efficient subcutaneous tissue support and volumetric augmentation. *J Drugs Dermatol.* 2012;11:45–47.
13. Viana GA, Osaki MH, Cariello AJ, et al. Treatment of the tear trough deformity with hyaluronic acid. *Aesthet Surg J.* 2011;31:225–231.
14. De Pasquale A, Russa G, Pulvirenti M, Di Rosa L. Hyaluronic acid filler injections for tear-trough deformity: injection technique and high-frequency ultrasound follow-up evaluation. *Aesthetic Plast Surg*. 2013 Apr 26. [Epub ahead of print].
15. Sharad J. Dermal fillers for the treatment of tear trough deformity: a review of anatomy, treatment techniques, and their outcomes. *J Cutan Aesthet Surg.* 2012;5:229–238.
16. Kashkouli MB, Heirati A, Pakdel F, Kiavash V. Diplopia after hyaluronic acid gel injection for correction of facial tear trough

deformity. *Orbit.* 2012;31:330–331.
17. Donath AS, Glasgold RA, Meier J, Glasgold MJ. Quantitative evaluation of volume augmentation in the tear trough with a hyaluronic acid-based filler: a three-dimensional analysis. *Plast Reconstr Surg.* 2010;125:1515–1522.
18. Wollina U, Goldman A. Hyaluronic acid dermal fillers: Safety and efficacy for the treatment of wrinkles, aging skin, body sculpturing and medical conditions. *Clin Med Rev Therapeutics.* 2011:3. doi: 10.4137/CMRT.S6928.
19. Flynn TC, Sarazin D, Bezzola A, et al. Comparative histology of intradermal implantation of mono and biphasic hyaluronic acid fillers. *Dermatol Surg.* 2011;37:637–643.
20. Lizzul PF, Narurkar VA. The role of calcium hydroxylapatite (Radiesse) in nonsurgical aesthetic rejuvenation. *J Drugs Dermatol.* 2010;9:446–450.
21. Jacovella PF, Peiretti CB, Cunille D, et al. Long-lasting results with hydroxylapatite (Radiesse) facial filler. *Plast Reconstr Surg*. 2006;118(3 Suppl):15S–21S.
22. Jacovella PF. Use of calcium hydroxylapatite (Radiesse) for facial augmentation. *Clin Interv Aging.* 2008;3:161–174.
23. Graivier MH. The role of Radiesse® in facial shaping. In: Cohen SR, Born TM, eds. *Facial Rejuvenation with Fillers. Techniques in Aesthetic Plastic Surgery.* Philadelphia/PA: Saunders–Elsevier; 2009:39–52.
24. Hevia O. A retrospective review of calcium hydroxyl apatite for correction of volume loss in the infraorbital Region. *Dermatol Surg.* 2009;35:1487–1494.
25. Quan T, Wang F, Shao Y, et al. Enhancing structural support of the dermal microenvironment activates fibroblasts, endothelial cells, and keratinocytes in aged human skin *in vivo*. *J Invest Dermatol.* 2013;133:658–667.
26. Turlier V, Delalleau A, Casas C, et al. Association between collagen production and mechanical stretching in dermal extracellular matrix: in vivo effect of cross-linked hyaluronic acid filler. A randomised, placebo-controlled study. *J Dermatol Sci.* 2013;69:187–194.
27. Rzany B, Becker-Wegerich B, Bachmann F, et al. Hyaluronidase in the correction of hyaluronic acid-based fillers: a review and recommendation for use. *J Cosmet Dermatol.* 2009;8:317–323.
28. Wollina U. Treatment of facial skin laxity by a new monopolar radiofrequency device. *J Cutan Aesthet Surg.* 2011;4:7–11.
29. Dayan SH, Bassichis SH. Facial dermal fillers: Selection of appropriate products and techniques. *Aesthetic Surg J.* 2008;28:335–347.
30. Kane MA. Treatment of tear trough deformity and lower lid bowing with injectable hyaluronic acid. *Aesthetic Plast Surg* 2005;29:363–367.
31. Morley AM, Malhotra R. Use of hyaluronic acid filler for tear-trough rejuvenation as an alternative to lower eyelid surgery. Ophthal Plast Reconstr Surg 2011;27:69–73.
32. Tung R, Ruiz de Luzuriaga AM, Park K, et al. Brighter eyes: combined upper cheek and tear trough augmentation: a systematic approach utilizing two complementary hyaluronic acid fillers. *J Drugs Dermatol.* 2012;11:1094–1097.